

4 Precipitation

4.1 General Description

As with temperature and terrain, Montana precipitation varies widely from one location to another. In some respects, the average precipitation map looks much like the terrain map (see Figs 1 and 2). The period of maximum rainfall occurs in the spring and early summer for most of the state. Rainfall/snowfall is greatest over the mountains at higher elevations. The driest areas of the state are in the southwest valleys and across the Hi-Line in north central Montana. Average precipitation for the state is 18.49-inches, but it varies from around nine to nearly 80-inches.

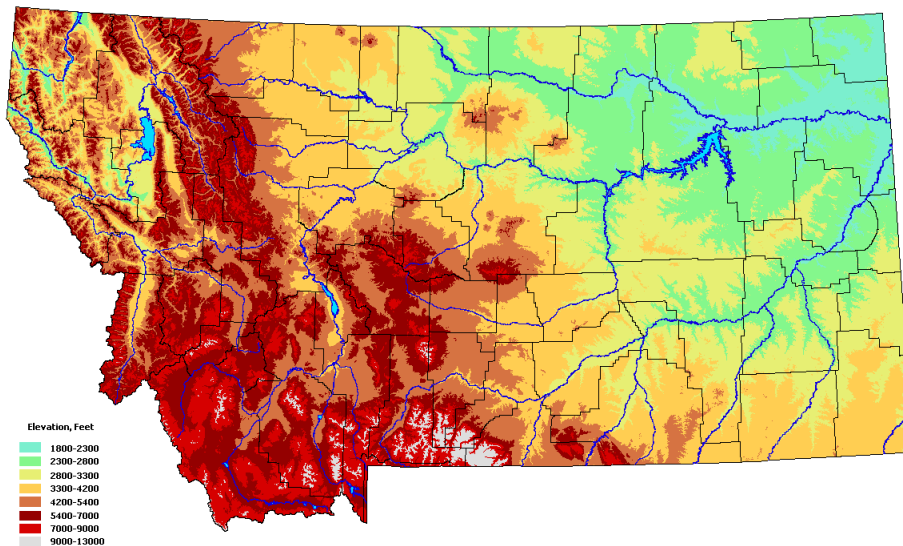


Figure 1. Topography map of Montana (courtesy MT Natural Resources Information Center).

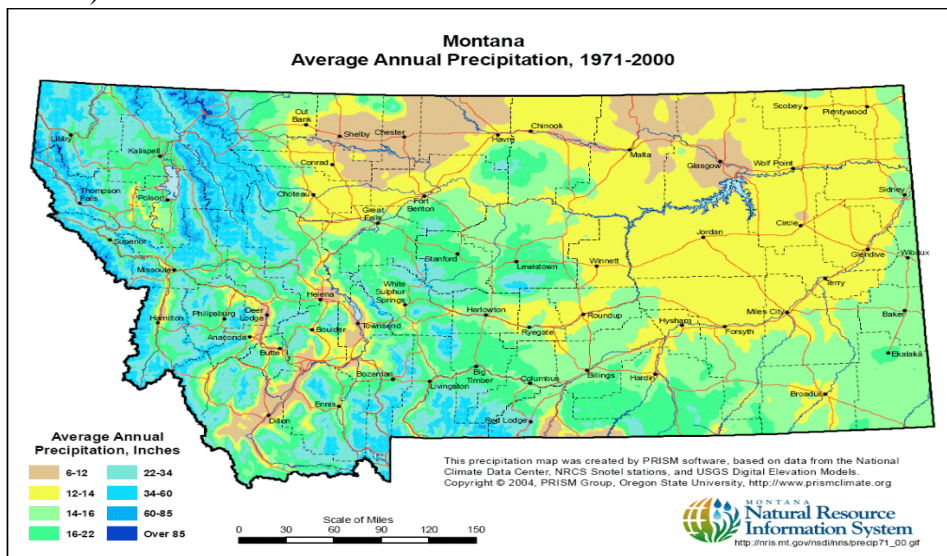


Figure 2. Prism annual average precipitation map (1971-2000) of Montana (courtesy Montana NRIS).

Table 4.1 Record precipitation events in Montana (inches)

Maximum annual	138.20 122.4 98.40 98.30 97.70 96.30 55.51	1953-54 1990 2001-02 1996-97 1989 2001-02 1953	Grinnell Glacier Flattop Mountain Poorman Creek Noisy Basin Flattop Mtn Poorman Creek Summit
Minimum annual	2.97	1960	Belfry
Max 24-hours	2.60 2.57	30 Aug 1989 29 Jul 1982	Glendive Kalispell
Average Maximum annual	79.90 73.80 73.00 49.40 32.94		Flattop Mountain NF Jocko Noisy Basin Many Glacier Hungry Horse
Average Minimum Annual	9.04 9.82		Glen 4N Joplin

During the summer, showers and thunderstorms occur frequently, but often amount to less than one-tenth of an inch of rain. Occasionally thunderstorms with heavy rain will produce amounts of more than two-inches in a 24-hour period. The greatest 24-hour amount recorded in Montana is 11.50 inches at Circle on June 20, 1921. Other record precipitation amounts are listed in Table 4.1. On average, precipitation occurs on one in five days across the state.

Over the eastern plains, most precipitation occurs during the spring and summer months. Figure 3 shows that a large percentage of the annual precipitation falls in June east of the divide. Figure 4 shows the high percentage of the annual precipitation that falls during the spring in eastern Montana.

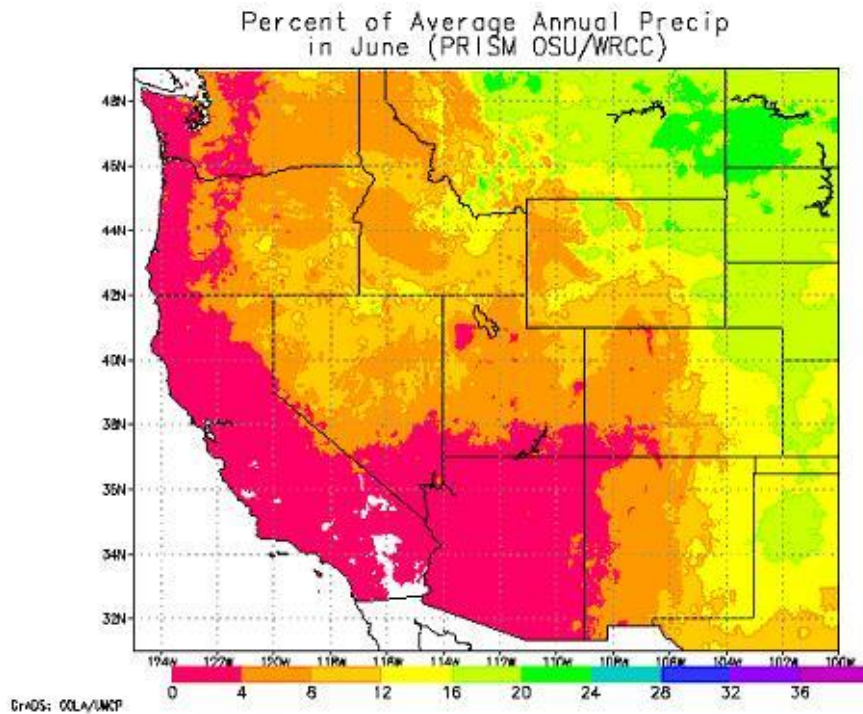


Figure 3. June is the peak month for annually distributed precipitation across eastern Montana.

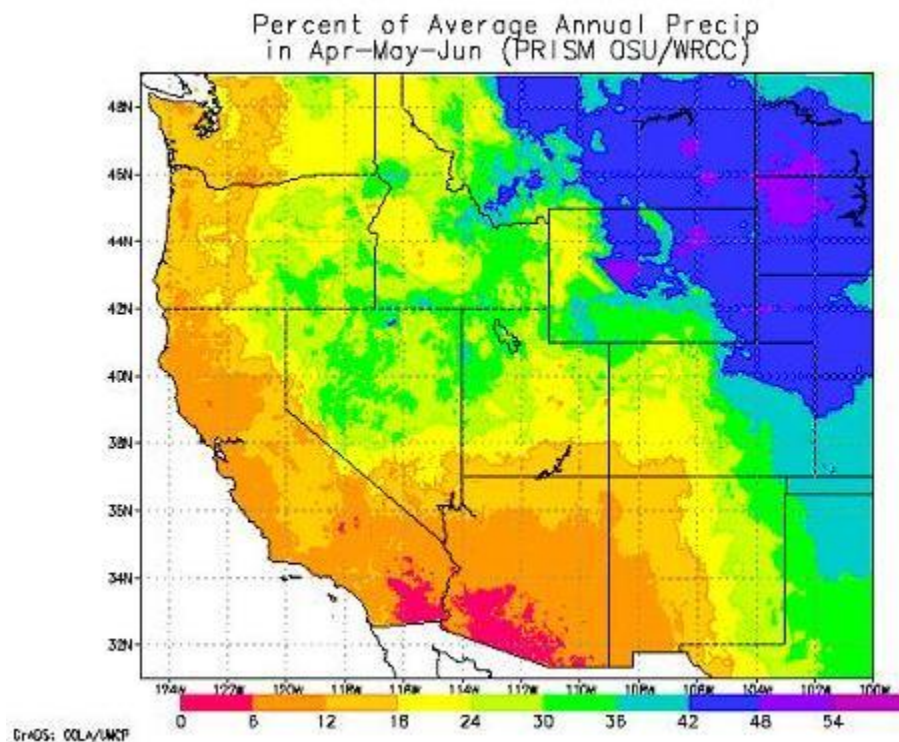


Figure 4. Spring precipitation percent of annual amount in Montana.

4.2 Probability return rates of precipitation

Thirty-day probability return rates of precipitation for Great Falls (Fig 5.1) show that amounts of less than two-tenths of an inch are sure to occur throughout the year, but monthly amounts as high as three-inches occur close to 40% of the time during the spring. Though amounts are smaller west of the divide, the general trend holds across the state (Remaining Fig 5.2-5.4).

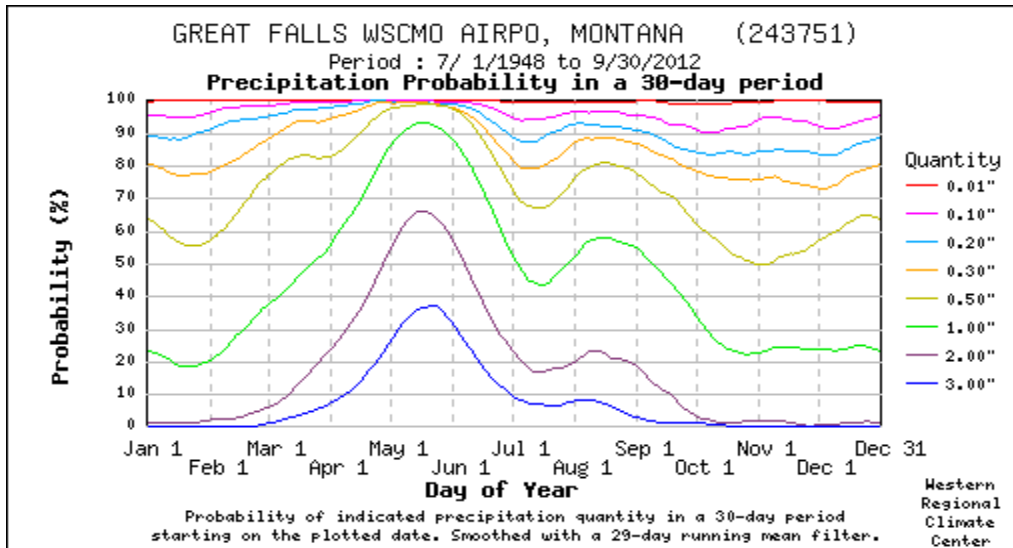


Figure 5.1 30-day precipitation probability for various totals at Great Falls.

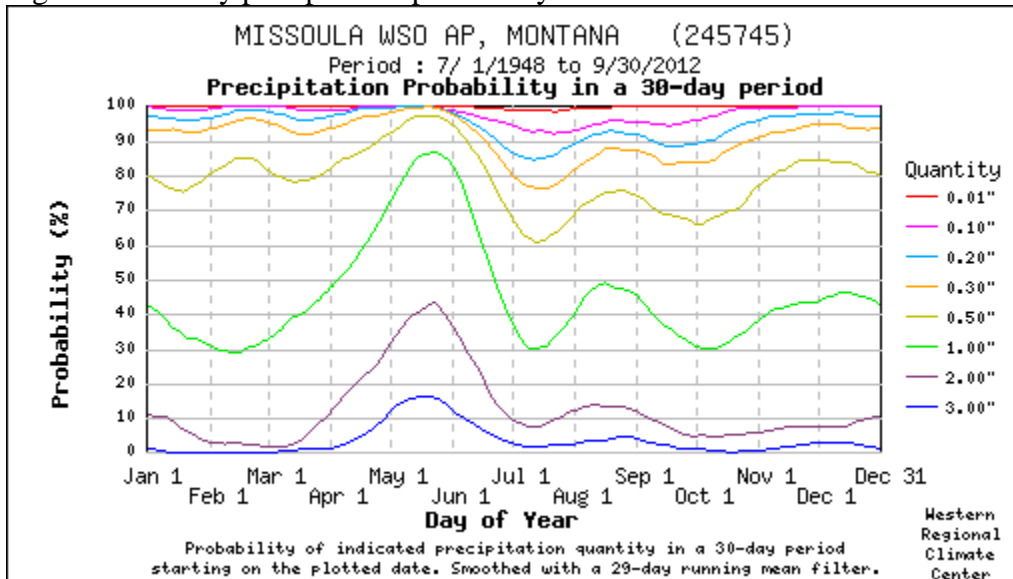


Figure 5.2 30-day precipitation probability for various totals at Missoula.

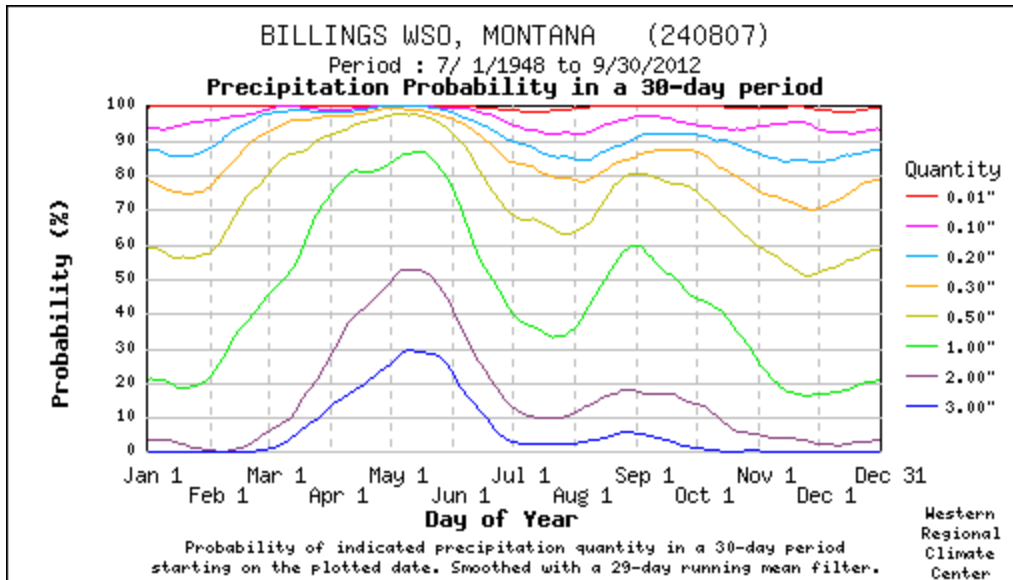


Figure 5.3 30-day precipitation probability for various totals at Billings.

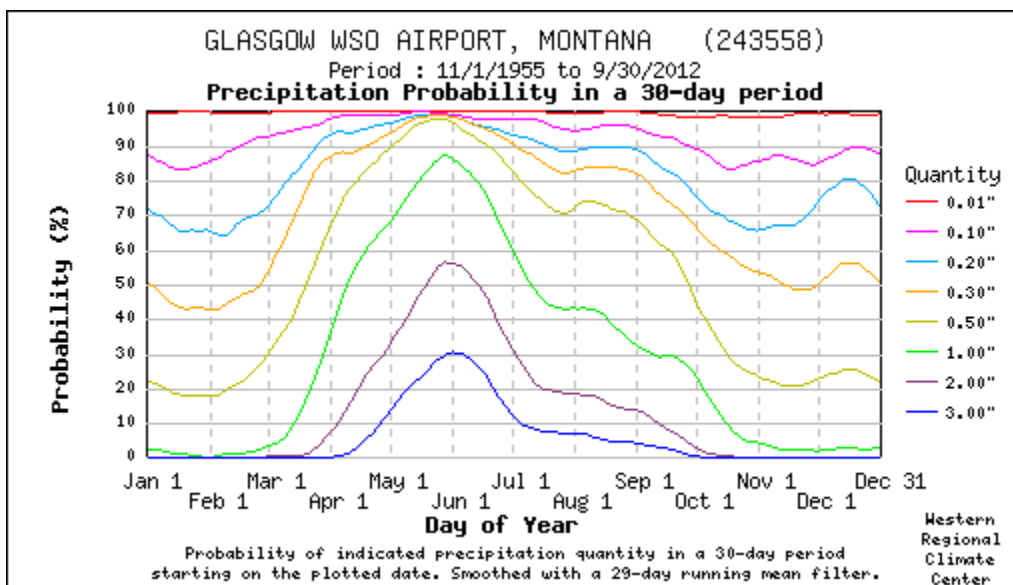


Figure 5.4 30-day precipitation probability for various totals at Glasgow.

4.3 Precipitation variability

In a 4-year period, increased variability in rainfall results in the same long-term average amounts, but impacts the ecosystem in two ways. First, the grassland biomass is reduced by fewer precipitation events with greater rainfall amounts per event as compared to more events with lesser rainfall amounts per event. Second, plant species diversity increases. Thus, these findings suggest that the prairie can exhibit rapid changes to its biodiversity even though the climate rainfall totals do not show long-term trends. In Figure 6, the inter-seasonal precipitation during the critical April-June time frame reveals that most of the Northern Plains can experience up to 70% variation between the highest 20th and lowest 20th percentiles.

Longer term, records from 1866-2014 indicate a variable precipitation trend for the state. While consecutive years had above or below normal precipitation in the 1800s and early 1900s, it is more variable on a year-to-year basis recently. Only in the late 1990s did the state again see a persistent period of below normal precipitation. Figure 7 shows the annual variability.

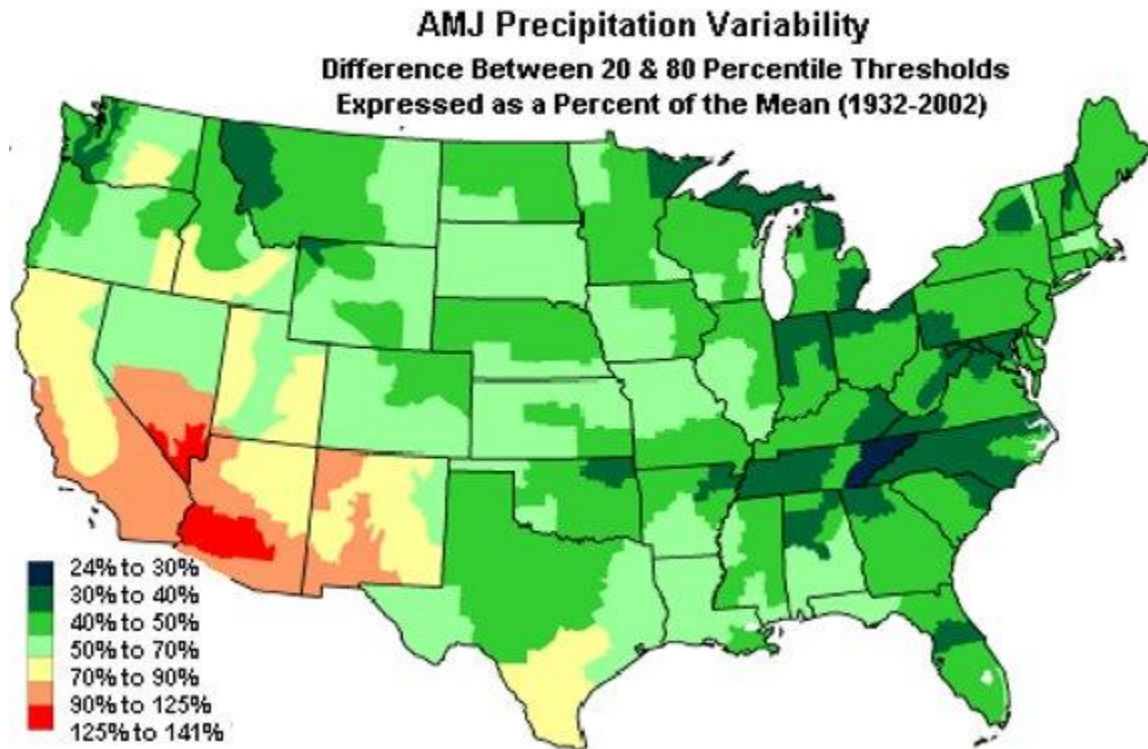


Figure 6. April through June precipitation variability for the U.S. based on 1932-2002 means.

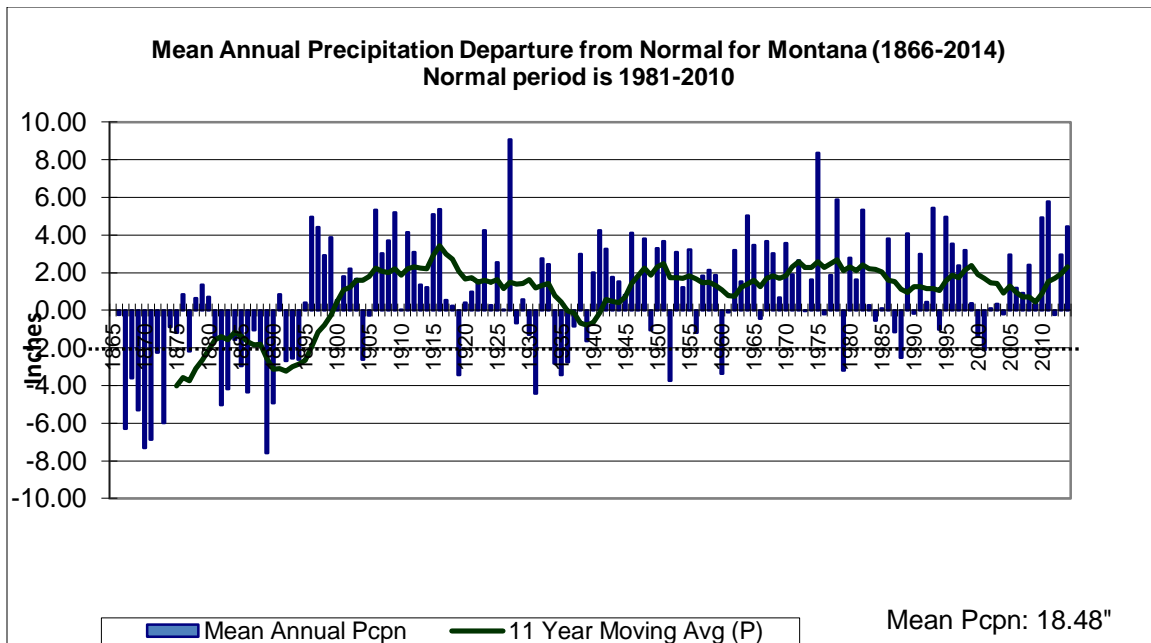


Figure 7. Mean annual statewide precipitation departure from normal, with an 11-year moving average.

The following tables show extreme precipitation amounts over monthly (Table 2), daily or hourly (Table 3), and monthly and yearly (Table 4).

4.4 Monthly and 24-hour record precipitation in Montana

Table 2. Montana monthly record precipitation and maximum 24-hour amount (inches)

Jan	14.00	1953	Summit	5.38	31/1954	Summit
	19.80	2006	Flattop Mtn			
	23.20	1972	Twin Lakes			
Feb	8.52	1979	Summit	2.85	27/1951	Lincoln
	17.25	1979	Poorman Creek	5.50	3/1990	NF Jocko
Mar	9.90	2014	Many Glacier	4.46	25/1935	Haugen
	18.30	2014	Flattop Mtn			
Apr	9.21	2010	Raynesford	4.67	17/1971	Billings WTP
	13.70	1993	Noisy Basin	5.50	28/2010	Crystal Lake
May	13.80	2011	Red Lodge	7.75	17/2000	Red Lodge
	16.44	2011	Zortman			
	17.80	2013	Crystal Lake			
Jun	18.17	1906	Warrick	11.50	20/1951	Circle
	16.79	1921	Circle			
	15.80	2005	Noisy Basin			
Jul	12.67	1993	Plentywood	6.55	22/1993	Plentywood
	8.10	1993	Noisy Basin			
Aug	8.01	1985	Lewistown 10S	5.70	5/1916	Glendive
	12.10	2004	Noisy Basin			
Sep	9.39	1986	Content	5.80	12/1978	Shonkin
	11.40	2004	Noisy Basin			
Oct	8.47	1950	Heron	4.40	26/1931	Billings WTP

	12.20	1990	Many Glacier			
Nov	12.50	1909	Saltese	3.80	6/1986	Deborgia
	25.10	2006	Poorman Creek	6.00	6-7/2006	Flatop Mtn
Dec	9.10	1912	Saltese	3.16	16/1979	Lindberg Lndg
	14.30	1999	Flatop Mtn	4.90	5/1989	NF Jocko

Table 3. Precipitation thresholds – most in time

	24 hr		1 hr	
Billings	3.34	24-25 May 2011	1.86	2 Jul 1958
Bozeman	3.10	26 Jun 1969	1.00	1 Aug 1948
Cut Bank	3.11	19-20 Jun 1975	0.80	20 Jun 1991
Dillon	2.10	18 Jul 1987	0.65	24 Jun 1958
Glasgow	4.99	2 Aug 1985	1.98	2 Aug 1985
Glendive	5.80	5-Aug-1916	2.60	30-Aug-1989
Great Falls	3.42	24-25 May 1980	1.13	20 Jun 1991
Havre	3.71	15-16 Jun 1887	1.74	23 Aug 1965
Helena	3.67	4-5 Jun 1908	1.29	18 Jun 1979
Kalispell	2.71	29 Jun 1982	2.57	29 Jul 1982
Lewistown	4.55	21 May 1962	1.33	20 May 1962
Miles City	3.54	20-May 1908	1.00	18-Jun-1964
Missoula	2.32	5 Nov 1927	1.13	21 Jul 1987

Table 4. Most in 1 month, 1 year, least in one year

	1 month		1 year		1 year	
Billings	9.54	May 2011	26.81	1978	7.90	1948
Bozeman	7.29	Jun 1969	20.04	1969	7.81	1936
Butte	8.86	Jun 1913	20.55	1909	6.89	1935
Cut Bank	8.97	Jul 1993	23.34	1975	4.66	1918
Dillon	6.30	Jun 1944	14.60	1987	6.20	2012
Glasgow	10.29	Jun 1923	22.93	2011	6.74	1984
Great Falls	8.13	May 1953	25.24	1975	6.68	1904
Havre	9.67	Jul 1884	25.67	1884	4.99	1990
Helena	6.67	Jun 1927	20.94	1975	6.26	1973
Kalispell	6.02	Jul 1993	25.23	1996	10.42	1944
Lewistown	10.82	Jun 1944	28.11	1978	11.15	1956
Livingston	9.60	May 1908	25.79	1925	8.07	1934
Miles City	9.78	Jun 1944	20.54	1915	5.27	1988
Missoula	7.38	May 1980	21.92	1998	8.16	1931
West Yellowstone	9.80	Dec 1996	29.32	1955	11.96	1931

Table 5. Average wettest and driest months of record, and mean monthly precipitation in Montana (inches)

Average Wettest and Driest Months of record, and mean monthly pcpn in Montana					
Month	Wettest	Year	Driest	Year	Mean
January	3.67-in	1881	0.20-in	1900	1.16-in

February	1.55-in	1986	0.18-in	2005	0.93-in
March	1.98-in	1898	0.15-in	1887	1.29-in
April	2.28-in	2006	0.30-in	1888	1.65-in
May	5.11-in	1927	0.56-in	1937	2.59-in
June	5.39-in	1944	0.46-in	1889	2.71-in
July	5.12-in	1993	0.38-in	1890	1.65-in
August	2.84-in	1933	0.21-in	1955	1.30-in
September	2.91-in	1941	0.13-in	2013	1.41-in
October	2.58-in	1975	0.04-in	1987	1.35-in
November	2.04-in	1897	0.09-in	1904	1.27-in
December	2.52-in	1917	0.17-in	1913	1.18-in
Year	20.94-in	1975	8.51-in	1919	18.49-in

Table 5 shows the average wettest and driest months of record in Montana. Tables 6 and 7 show duration rainfall, from 5 minutes through 12 hours.

Table 6. Rainfall records for short duration in Montana.

Rainfall period			
5 minutes	0.78"	Billings	Aug 5, 2011
	0.64"	Kalispell	Jun 23, 2012
	0.59"	Havre	Jun 20, 2003
10 minutes	0.98"	Billings	Aug 5, 2011
	0.93"	Havre	Jun 20, 2003
	0.77"	Kalispell	Jun 23, 2012
15 minutes	1.60"	Glendive	Aug 30, 1989
	1.60"	St Regis	Aug 22, 1989
	1.10"	Ekalaka	Jul 17, 1993
30 minutes	2.40"	Glendive	Aug 30, 1989
	1.60"	St Regis	Aug 22, 1989
	1.50"	Ashland	Jul 17, 1993
45 minutes	2.60"	Glendive	Aug 30, 1989
	1.60"	Ashland	Jul 17, 1993
	1.60"	St Regis	Aug 22, 1989
1 hour	2.60"	Glendive	Aug 30, 1989
	2.57"	Kalispell	Jun 29, 1982
	1.98"	Glasgow	Aug 2, 1985
2 hours	2.60"	Glendive	Aug 30, 1989
	2.59"	Kalispell	Jun 29, 1982

	2.56"	Glasgow	Jun 16, 2007
3 hours	2.99"	Broadus	Jun 9, 1972
	2.70"	Glendive	Aug 30, 1989
	2.59"	Kalispell	Jun 29, 1982
4 hours	3.13"	Broadus	Jun 9, 1972
	3.10"	Fort Peck	May 1, 1953
	2.82"	Glasgow	Aug 2, 1985
5 hours	3.35"	Fort Peck	May 1, 1953
	3.17"	Broadus	Jun 9, 1972
	3.00"	Glendive	Aug 30, 1989
6 hours	3.42"	Fort Peck	May 1, 1953
	3.17"	Broadus	Jun 9, 1972
	3.00"	Glendive	Aug 30, 1989
7 hours	3.42"	Fort Peck	May 1, 1953
	3.37"	Summit	Jun 8, 1964
	3.32"	Browning	Jun 8, 1964
8 hours	3.77"	Summit	Jun 8, 1964
	3.70"	Browning	Jun 8, 1964
	3.42"	Fort Peck	May 1, 1953
9 hours	4.12"	Summit	Jun 8, 1964
	4.05"	Browning	Jun 8, 1964
	3.44"	Gibson Dam	Jun 8, 1964
10 hours	4.45"	Summit	Jun 8, 1964
	4.18"	Browning	Jun 8, 1964
	3.67"	Gibson Dam	Jun 8, 1964
11 hours	4.75"	Summit	Jun 8, 1964
	4.28"	Browning	Jun 8, 1964
	3.84"	Gibson Dam	Jun 8, 1964
12 hours	5.19"	Summit	Jun 8, 1964
	4.53"	Browning	Jun 8, 1964
	4.03"	Gibson Dam	Jun 8, 1964

Table 7. Short-duration rainfall records at larger points in Montana

	Billing s	Cut Bank	Dillon	Glasgow	Glendive	Great Falls	Havre	Helen a	Kalispell	Lewistown	Miles City	Missoula	W Yellowstone
5 mi n	0.78 Aug 5, 2011			0.28 Aug 29, 2011		0.38 Jul 6, 2012	0.59 Jun 20, 2003	0.32 Aug 2, 2004	0.64 Jun 23, 2012			0.23 Jun 27, 2001	
10 mi n	0.98 Aug 5, 2011			0.28 Aug 29, 2011		0.50 Jul 14, 2012	0.93 Jun 20, 2003	0.55 Aug 2, 2004	0.77 Jun 23, 2012			0.36 Jun 27, 2001	
15 mi n	1.00 Aug 5, 2011	0.40 Jun 20, 1991		0.28 Aug 29, 2011	1.60 Aug 30, 1989	0.66 Jul 14, 2012	0.96 Jun 20, 2003	0.66 Aug 2, 2004	0.77 Jun 23, 2012			0.45 Jun 27, 2001	0.90 Jul 22, 1985
30 mi n	1.00 Aug 5, 2011	0.50 Jun 20, 1991		0.35 Aug 29, 2011	2.40 Aug 30, 1989	1.04 Jul 14, 2012	0.97 Jun 20, 2003	0.90 Aug 2, 2004	0.77 Jun 23, 2012			0.50 Jun 27, 2001	1.30 Jul 22, 1985
45 mi	1.00 Aug 5,	0.70 Jun		0.35 Aug 29,	2.60 Aug 30,	1.08 Jul	1.16 Jul	1.02 Aug 2,	0.77 Jun 23,			0.54 Jun 27, 2001	1.50 Jul 22, 1985

n	2011	20, 1991		2011	1989	14, 2012	12, 2001	2004	2012				
60 mi n	1.86 Jul 2, 1958	0.80 Jun 20, 1991	0.65 Jun 24, 1958	1.98 Aug 2, 1985	2.60 Aug 30, 1989	1.13 Jun 20, 1991	1.23 Aug 23, 1965	1.23 Jun 18, 1979	2.57 Jun 29, 1982	1.33 May 20, 1982	0.75 Jun 1, 1962	1.13 Jul 21, 1987	1.60 Jul 22, 1985
2 hrs	2.24 Jun 20, 2010	1.10 Jun 20, 1991	0.85 Jun 24, 1958	2.48 Aug 2, 1985	2.60 Aug 30, 1989	1.14 Jun 20, 1991	1.74 Aug 23, 1965	1.44 Jun 18, 1979	2.59 Jun 29, 1982	1.83 May 20, 1982	1.15 Jun 1, 1962	1.21 Jul 21, 1987	1.80 Jul 22, 1985
3 hrs	1.94 May 25, 2011	1.30 Jun 20, 1991	0.99 Jun 24, 1958	2.66 Aug 2, 1985	2.70 Aug 30, 1989	1.14 Jun 20, 1991	1.75 Aug 23, 1965	1.67 Jun 18, 1979	2.59 Jun 29, 1982	2.13 May 20, 1982	1.24 Jun 1, 1962	1.28 Jul 21, 1987	2.00 Jul 22, 1985
4 hrs	2.14 May 25, 2011	1.30 Jun 20, 1991	1.10 Jun 24, 1958	2.82 Aug 2, 1985	2.70 Aug 30, 1989	1.15 Jun 20, 1991	1.75 Aug 23, 1965	1.68 Jun 18, 1979	2.67 Jun 29, 1982	2.36 May 20, 1982		1.52 Jul 21, 1987	2.10 Jul 22, 1985
5 hrs	2.58 May 25, 2011	1.40 Jun 20, 1991	1.20 Jun 24, 1958	2.88 Aug 2, 1985	3.00 Aug 30, 1989	1.26 Jun 20, 1991	1.75 Aug 23, 1965	1.68 Jun 18, 1979	2.68 Jun 29, 1982	2.40 May 20, 1982		1.58 Jul 21, 1987	
6 hrs	2.68 May 25, 2011	1.60 Jun 20, 1991	1.26 Jun 24, 1958	2.91 Aug 2, 1985	3.00 Aug 30, 1989	1.26 Jun 20, 1991	1.75 Aug 23, 1965	1.73 Jun 18, 1979	2.68 Jun 29, 1982	2.62 May 20, 1982		1.58 Jul 21, 1987	
7 hrs	2.72 May 25, 2011	1.60 Jun 20, 1999	1.30 Jun 24, 1958	2.96 Aug 2, 1985				1.76 Jun 18, 1979				1.63 Jul 21, 1987	
8 hrs	2.74 May 25, 2011	1.80 Sep 5-6, 2013	1.31 Jun 24, 1958					1.77 Jun 18, 1979				1.65 Jul 21, 1987	
9 hrs	2.84 May 25, 2011	1.88 Sep 5-6, 2013						1.78 Jun 18, 1979				1.67 Jul 21, 1987	
10 hrs	2.88 May 25, 2011	2.01 Sep 5-6, 2013											
11 hrs	3.00 May 25, 2011	2.10 Sep 5-6, 2013											
12 hrs	3.04 May 25, 2011	2.11 Sep 5-6, 2013											
	Billing s	Cut Ban k	Dillo n	Glasgo w	Glendiv e	Grea t Falls	Havr e	Helen a	Kalispel l	Lewistow n	Mile s City	Missoul a	W Yellowston e